CLAIMS

1. A training method for a power amplifier pre-distorter formed by a FIR filter structure including

an individual look-up table for each filter tap, each look-up table representing a discretized polynomial in a variable representing input signal amplitude, and

means for selecting, from each filter tap look-up table, a filter coefficient that depends on the amplitude of a corresponding complex signal value to be multiplied by the filter tap, said training method including the steps of

storing measured unamplified input signal samples and corresponding power amplifier output signal feedback samples; and

using said stored samples to individually determine look-up table filter coefficients by independent iterative procedures.

2. The method of claim 1, wherein said iterative procedures are least mean square based.

3. The method of claim 2, including the step of calculating a refined filter coefficient estimate $T_{qi}(b)$ corresponding to a filter tap with a delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{qi-1}(b)$ in accordance with the equation:

$$T_{qi}(b) = T_{qi-1}(b) + \mu_q \cdot \frac{1}{N_b} \cdot \sum_{|x_{k-q}| \in M_b} \frac{x_k - y_k}{|x_{k-q}|^2} \cdot x_{k-q}^*$$

where

μ_q is a predetermined constant associated with filter tap q,

N_b is the number of stored input signal samples that have an amplitude that falls within a predetermined window M_b around the center amplitude of bin b,

x_{k-q} is a stored input signal sample that has a delay q,

y_k is a power amplifier output signal feedback sample corresponding to power amplifier input signal sample x_k,

* denotes complex conjugation.

4. The method of claim 2, including the step of calculating a refined filter coefficient estimate $T_{ql}(b)$ corresponding to a filter tap with a delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{ql-1}(b)$ in accordance with the equation:

$$\begin{cases} T_{ql}(b) = T_{ql-1}(b) + \mu_q \cdot u(b) \dfrac{1}{N_b} \cdot \sum\limits_{|x_{k-q}| \in M_b} (x_k - y_k) \cdot x_{k-q}^* \\ u(b) = \dfrac{1}{\overline{|x_b|}^2} \end{cases}$$

where

μ_q is a constant associated with filter tap q,

N_b is the number of stored input signal samples that have an amplitude that falls within a predetermined window M_b around the center amplitude $\overline{|x_b|}$ of bin b,

x_{k-q} is a stored input signal sample that has a delay q,

y_k is a power amplifier output signal feedback sample corresponding to input signal sample x_k,

* denotes complex conjugation.

5. The method of claim 2, including the step of calculating a refined filter coefficient estimate $T_{ql}(b)$ corresponding to a filter tap with a delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{ql-1}(b)$ in accordance with the equation:

$$T_{ql}(b) = T_{ql-1}(b) + \mu_q \cdot (x_k - y_k) \cdot \frac{x_{k-q}^*}{\left|x_{k-q}\right|^2} : \quad \left|x_{k-q}\right| \in M_b$$

where

μ_q is a constant associated with filter tap q,

x_{k-q} is a stored input signal sample that has that has a delay q and an amplitude that falls within a predetermined window M_b around the center amplitude of bin b,

y_k is a power amplifier output signal feedback sample corresponding to input signal sample x_k,

* denotes complex conjugation.

6. The method of claim 2, including the step of calculating a refined filter coefficient estimate $T_{ql}(b)$ corresponding to a filter tap with a delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{ql-1}(b)$ in accordance with the equation:

$$\begin{cases} T_{ql}(b) = T_{ql-1}(b) + \mu_q \cdot u(b) \cdot (x_k - y_k) \cdot x_{k-q}^* : \quad \left|x_{k-q}\right| \in M_b \\ u(b) = \dfrac{1}{\overline{\left|x_b\right|}^2} \end{cases}$$

where

μ_q is a constant associated with filter tap q,

x_{k-q} is a stored input signal sample that has a delay q and an amplitude that falls within a predetermined window M_b around the center amplitude $\overline{|x_b|}$ of bin b,

x_k is a power amplifier input signal sample that y_{k-q} is a power amplifier output signal feedback sample corresponding to input signal sample x_k,

* denotes complex conjugation.

7. A power amplifier pre-distorter formed by a FIR filter structure including

an individual look-up table for each filter tap, each look-up table representing a discretized polynomial in a variable representing input signal amplitude, and

means for selecting, from each filter tap look-up table, a filter coefficient that depends on the amplitude of a corresponding complex signal value to be multiplied by the filter tap, said pre-distorter including

means (50) for storing measured unamplified input signal samples and corresponding power amplifier output signal feedback samples; and

means (48) for using said stored samples to individually determine look-up table filter coefficients by independent iterative procedures.

8. The pre-distorter of claim 7, including means (48, 50) for implementing said iterative procedures as least mean square based iterative procedures.

9. The pre-distorter of claim 8, including means (48) for calculating a refined filter coefficient estimate $T_{qi}(b)$ corresponding to a filter tap with a delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{qi-1}(b)$ in accordance with the equation:

$$T_{ql}(b) = T_{ql-1}(b) + \mu_q \cdot \frac{1}{N_b} \cdot \sum_{|x_{k-q}| \in M_b} \frac{x_k - y_k}{|x_{k-q}|^2} \cdot x_{k-q}^*$$

where

μ_q is a predetermined constant associated with filter tap q,

N_b is the number of stored input signal samples that have an amplitude that falls within a predetermined window M_b around the center amplitude of bin b,

x_{k-q} is a stored input signal sample that has a delay q,

y_k is a power amplifier output signal feedback sample corresponding to input signal sample x_k,

* denotes complex conjugation.

10. The pre-distorter of claim 8, including means (48) for calculating a refined filter coefficient estimate $T_{ql}(b)$ corresponding to a filter tap with a delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{ql-1}(b)$ in accordance with the equation:

$$\begin{cases} T_{ql}(b) = T_{ql-1}(b) + \mu_q \cdot u(b) \dfrac{1}{N_b} \cdot \displaystyle\sum_{|x_{k-q}| \in M_b} (x_k - y_k) \cdot x_{k-q}^* \\ u(b) = \dfrac{1}{\overline{|x_b|}^2} \end{cases}$$

where

μ_q is a constant associated with filter tap q,

N_b is the number of stored input signal samples that have an amplitude that falls within a predetermined window M_b around the center amplitude $\overline{|x_b|}$ of bin b,

x_{k-q} is a stored input signal sample that has a delay q,

y_k is a power amplifier output signal feedback sample corresponding to input signal sample x_k,

* denotes complex conjugation.

11. The pre-distorter of claim 8, including means (48) for calculating a refined filter coefficient estimate $T_{ql}(b)$ corresponding to a filter tap with a delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{ql-1}(b)$ in accordance with the equation:

$$T_{ql}(b) = T_{ql-1}(b) + \mu_q \cdot (x_k - y_k) \cdot \frac{x_{k-q}^*}{\left|x_{k-q}\right|^2} : \quad \left|x_{k-q}\right| \in M_b$$

where

μ_q is a constant associated with filter tap q,

x_{k-q} is a stored input signal sample that has that has a delay q and an amplitude that falls within a predetermined window M_b around the center amplitude of bin b,

y_k is a power amplifier output signal feedback sample corresponding to input signal sample x_k,

* denotes complex conjugation.

12. The pre-distorter of claim 8, including means (48) for calculating a refined filter coefficient estimate $T_{ql}(b)$ corresponding to a filter tap with a delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{ql-1}(b)$ in accordance with the equation:

$$\begin{cases} T_{qi}(b) = T_{qi-1}(b) + \mu_q \cdot u(b) \cdot (x_k - y_k) \cdot x_{k-q}^* : & |x_{k-q}| \in M_b \\ u(b) = \dfrac{1}{\overline{|x_b|}^2} \end{cases}$$

where

μ_q is a constant associated with filter tap q,

x_{k-q} is a stored input signal sample that has a delay q and an amplitude that falls within a predetermined window M_b around the center amplitude $\overline{|x_b|}$ of bin b,

x_k is a power amplifier input signal sample that y_{k-q} is a power amplifier output signal feedback sample corresponding to input signal sample x_k,

* denotes complex conjugation.

13. A power amplifier having a pre-distorter formed by a FIR filter structure including

an individual look-up table for each filter tap, each look-up table representing a discretized polynomial in a variable representing input signal amplitude, and

means for selecting, from each filter tap look-up table, a filter coefficient that depends on the amplitude of a corresponding complex signal value to be multiplied by the filter tap, said pre-distorter including

means (50) for storing measured unamplified input signal samples and corresponding power amplifier output feedback signal samples; and

means (48) for using said stored samples to individually determine look-up table filter coefficients by independent iterative procedures.

14. The power amplifier of claim 13, including means (48, 50) for implementing said iterative procedures as least mean square based iterative procedures.

15. The power amplifier of claim 14, including means (48) for calculating a refined filter coefficient estimate $T_{qi}(b)$ corresponding to a filter tap with a delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{qi-1}(b)$ in accordance with the equation:

$$T_{qi}(b) = T_{qi-1}(b) + \mu_q \cdot \frac{1}{N_b} \cdot \sum_{|x_{k-q}| \in M_b} \frac{x_k - y_k}{|x_{k-q}|^2} \cdot x_{k-q}^*$$

where

μ_q is a predetermined constant associated with filter tap q,

N_b is the number of stored input signal samples that have an amplitude that falls within a predetermined window M_b around the center amplitude of bin b,

x_{k-q} is a stored input signal sample that has a delay q,

y_k is a power amplifier output signal feedback sample corresponding to input signal sample x_k,

* denotes complex conjugation.

16. The power amplifier of claim 14, including means (48) for calculating a refined filter coefficient estimate $T_{ql}(b)$ corresponding to a filter tap with a delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{ql-1}(b)$ in accordance with the equation:

$$\begin{cases} T_{ql}(b) = T_{ql-1}(b) + \mu_q \cdot u(b) \dfrac{1}{N_b} \cdot \displaystyle\sum_{|x_{k-q}| \in M_b} (x_k - y_k) \cdot x_{k-q}^* \\ u(b) = \dfrac{1}{\overline{|x_b|^2}} \end{cases}$$

where

μ_q is a constant associated with filter tap q,

N_b is the number of stored input signal samples that have an amplitude that falls within a predetermined window M_b around the center amplitude $\overline{|x_b|}$ of bin b,

x_{k-q} is a stored input signal sample that has a delay q,

y_k is a power amplifier output signal feedback sample corresponding to input signal sample x_k,

* denotes complex conjugation.

17. The power amplifier of claim 14, including means (48) for calculating a refined filter coefficient estimate $T_{qi}(b)$ corresponding to a filter tap with a delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{qi-1}(b)$ in accordance with the equation:

$$T_{qi}(b) = T_{qi-1}(b) + \mu_q \cdot (x_k - y_k) \cdot \frac{x_{k-q}^*}{|x_{k-q}|^2} : \quad |x_{k-q}| \in M_b$$

where

μ_q is a constant associated with filter tap q,

x_{k-q} is a stored input signal sample that has that has a delay q and an amplitude that falls within a predetermined window M_b around the center amplitude of bin b,

y_k is a power amplifier output signal feedback sample corresponding to input signal sample x_k,

* denotes complex conjugation.

18. The power amplifier of claim 14, including means (48) for calculating a refined filter coefficient estimate $T_{qi}(b)$ corresponding to a filter tap with a

delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{qi-1}(b)$ in accordance with the equation:

$$\begin{cases} T_{qi}(b) = T_{qi-1}(b) + \mu_q \cdot u(b) \cdot (x_k - y_k) \cdot x^*_{k-q} : & |x_{k-q}| \in M_b \\ u(b) = \dfrac{1}{\overline{|x_b|}^2} \end{cases}$$

where

μ_q is a constant associated with filter tap q,

x_{k-q} is a stored input signal sample that has a delay q and an amplitude that falls within a predetermined window M_b around the center amplitude $\overline{|x_b|}$ of bin b,

x_k is a power amplifier input signal sample that y_{k-q} is a power amplifier output signal feedback sample corresponding to input signal sample x_k,

* denotes complex conjugation.

19. A base station provided with a power amplifier having a pre-distorter formed by a FIR filter structure including

an individual look-up table for each filter tap, each look-up table representing a discretized polynomial in a variable representing input signal amplitude, and

means for selecting, from each filter tap look-up table, a filter coefficient that depends on the amplitude of a corresponding complex signal value to be multiplied by the filter tap, said pre-distorter including

means (50) for storing measured unamplified input signal samples and corresponding power amplifier output signal feedback samples; and

means (48) for using said stored samples to individually determine look-up table filter coefficients by independent iterative procedures.

20. The base station of claim 19, including means (48, 50) for implementing said iterative procedures as least mean square based iterative procedures.

21. The base station of claim 20, including means (48) for calculating a refined filter coefficient estimate $T_{qi}(b)$ corresponding to a filter tap with a delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{qi-1}(b)$ in accordance with the equation:

$$T_{qi}(b) = T_{qi-1}(b) + \mu_q \cdot \frac{1}{N_b} \cdot \sum_{|x_{k-q}| \in M_b} \frac{x_k - y_k}{|x_{k-q}|^2} \cdot x_{k-q}^*$$

where

μ_q is a predetermined constant associated with filter tap q,

N_b is the number of stored input signal samples that have an amplitude that falls within a predetermined window M_b around the center amplitude of bin b,

x_{k-q} is a stored input signal sample that has a delay q,

y_k is a power amplifier output signal feedback sample corresponding to input signal sample x_k,

* denotes complex conjugation.

22. The base station of claim 20, including means (48) for calculating a refined filter coefficient estimate $T_{qi}(b)$ corresponding to a filter tap with a delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{qi-1}(b)$ in accordance with the equation:

$$\begin{cases} T_{qi}(b) = T_{qi-1}(b) + \mu_q \cdot u(b) \frac{1}{N_b} \cdot \sum_{|x_{k-q}| \in M_b} (x_k - y_k) \cdot x^{*}_{k-q} \\ u(b) = \frac{1}{\overline{|x_b|}^2} \end{cases}$$

where

μ_q is a constant associated with filter tap q,

N_b is the number of stored input signal samples that have an amplitude that falls within a predetermined window M_b around the center amplitude $\overline{|x_b|}$ of bin b,

x_{k-q} is a stored input signal sample that has a delay q,

y_k is a power amplifier output signal feedback sample corresponding to input signal sample x_k,

* denotes complex conjugation.

23. The base station of claim 20, including means (48) for calculating a refined filter coefficient estimate $T_{qi}(b)$ corresponding to a filter tap with a delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{qi-1}(b)$ in accordance with the equation:

$$T_{qi}(b) = T_{qi-1}(b) + \mu_q \cdot (x_k - y_k) \cdot \frac{x^{*}_{k-q}}{|x_{k-q}|^2} : \quad |x_{k-q}| \in M_b$$

where

μ_q is a constant associated with filter tap q,

x_{k-q} is a stored input signal sample that has that has a delay q and an amplitude that falls within a predetermined window M_b around the center amplitude of bin b,

y_k is a power amplifier output signal feedback sample corresponding to input signal sample x_k,

* denotes complex conjugation.

24. The base station of claim 20, including means (48) for calculating a refined filter coefficient estimate $T_{qi}(b)$ corresponding to a filter tap with a delay q and a signal amplitude bin b from a previous filter coefficient estimate $T_{qi-1}(b)$ in accordance with the equation:

$$\begin{cases} T_{qi}(b) = T_{qi-1}(b) + \mu_q \cdot u(b) \cdot (x_k - y_k) \cdot x^*_{k-q} : \quad |x_{k-q}| \in M_b \\ u(b) = \dfrac{1}{\overline{|x_b|}^2} \end{cases}$$

where

μ_q is a constant associated with filter tap q,

x_{k-q} is a stored input signal sample that has a delay q and an amplitude that falls within a predetermined window M_b around the center amplitude $\overline{|x_b|}$ of bin b,

x_k is a power amplifier input signal sample that y_{k-q} is a power amplifier output signal feedback sample corresponding to input signal sample x_k,

* denotes complex conjugation.
